Armament Technology For The Future Combat System

RArefaction waVE guN
RAVEN
Propulsion

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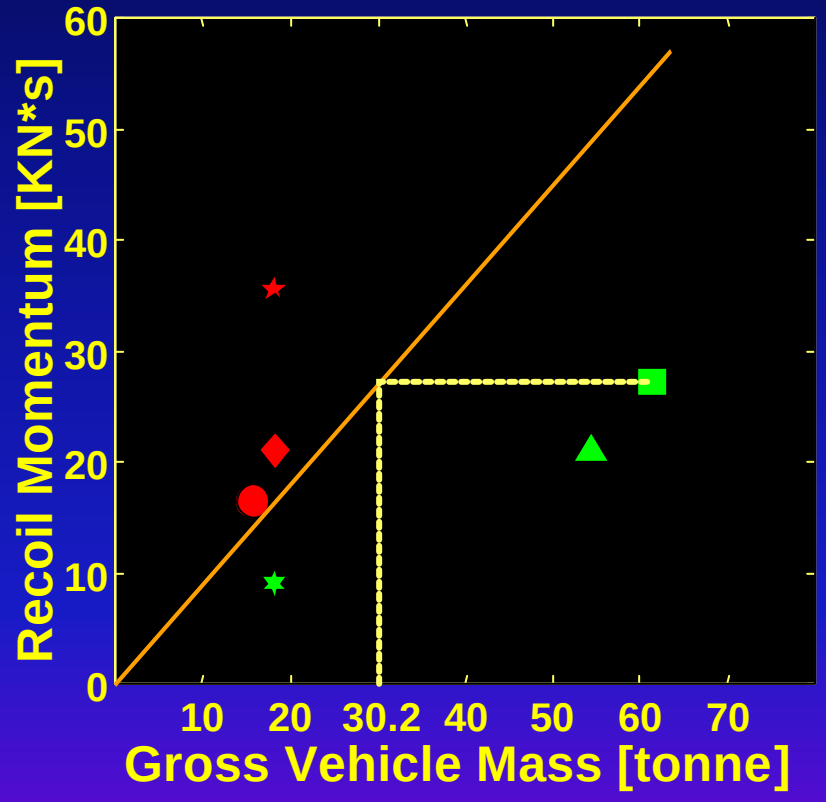
Recoil Impulse Metric



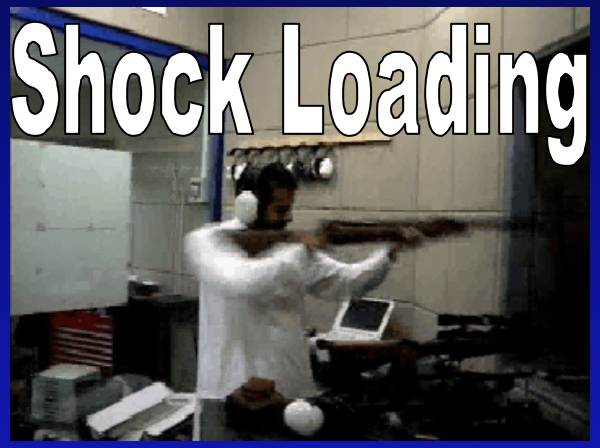
- M551 116% Ogorkiewicz Limit
- M1A1 49% Ogorkiewicz Limit
- M8 AGS 128% Ogorkiewicz Limit
- M60A1 43% Ogorkiewicz Limit
- FCS FOOB 218% Ogorkiewicz Limit
- FCS RAVEN 54% Ogorkiewicz Limit
- Ogorkiewicz Limit
- Traditional Limit for M1A1 Lethality

- Traditional fighting vehicle design limits the ratio of recoil impulse to vehicle mass.
- It is important to note, FCS is not traditional.

A Graphic Recoil Example

Recoil Effects

- Recoil energy:
  - Integral of recoil force by recoil stroke.
  - May be reduced via heavier gun, fire out of battery, or reduced impulse.



- Recoil Impulse:
  - Integral of recoil force by recoil duration.
  - May be reduced via muzzle brakes or RAVEN.

RAVEN

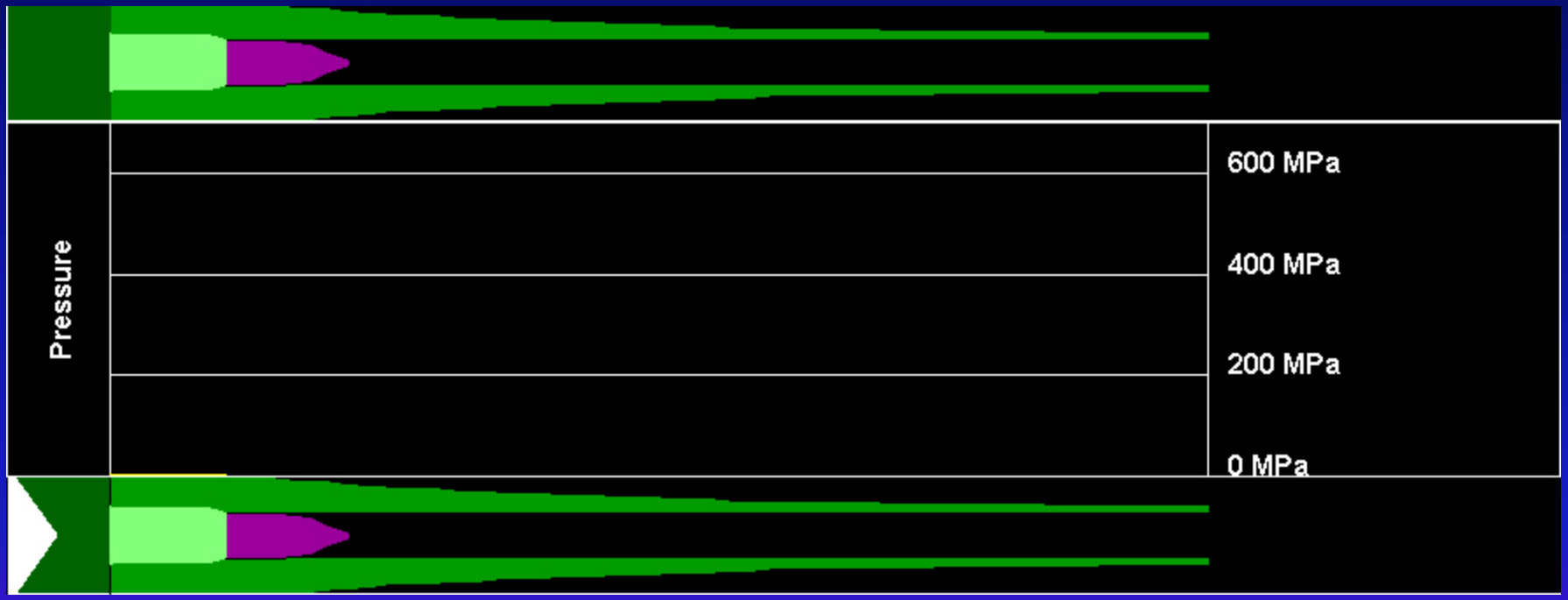
Advantages:

- Dramatic reduction in recoil momentum
  - 75% for KE Rod
- Substantial reduction in heat transfer to bore
  - 50% from the bore evacuator to muzzle
- Recoilless achievable with only modest efficiency loss.

Disadvantages:

- Back blast
- Cannon complexity

Pressure Wave Animation

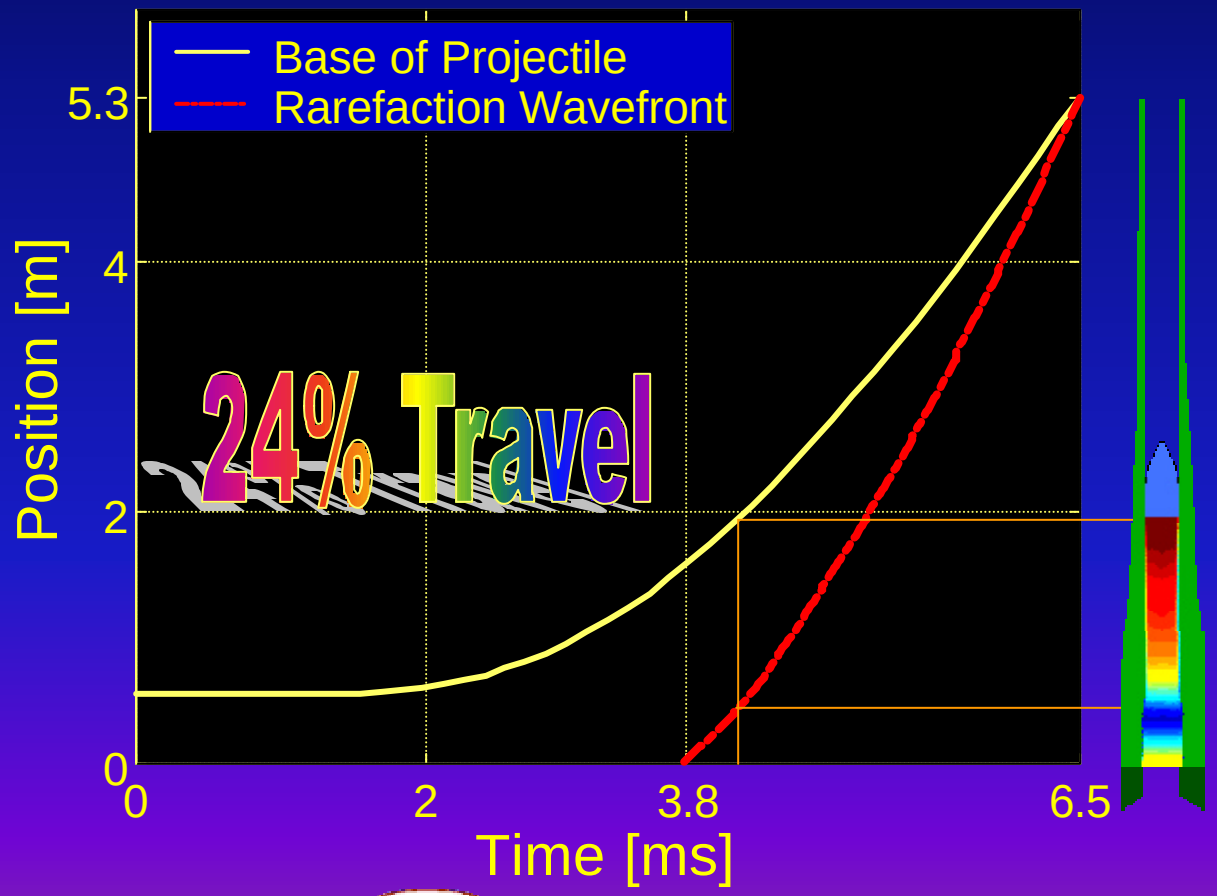


In collaboration with

Rarefaction Wave Progression

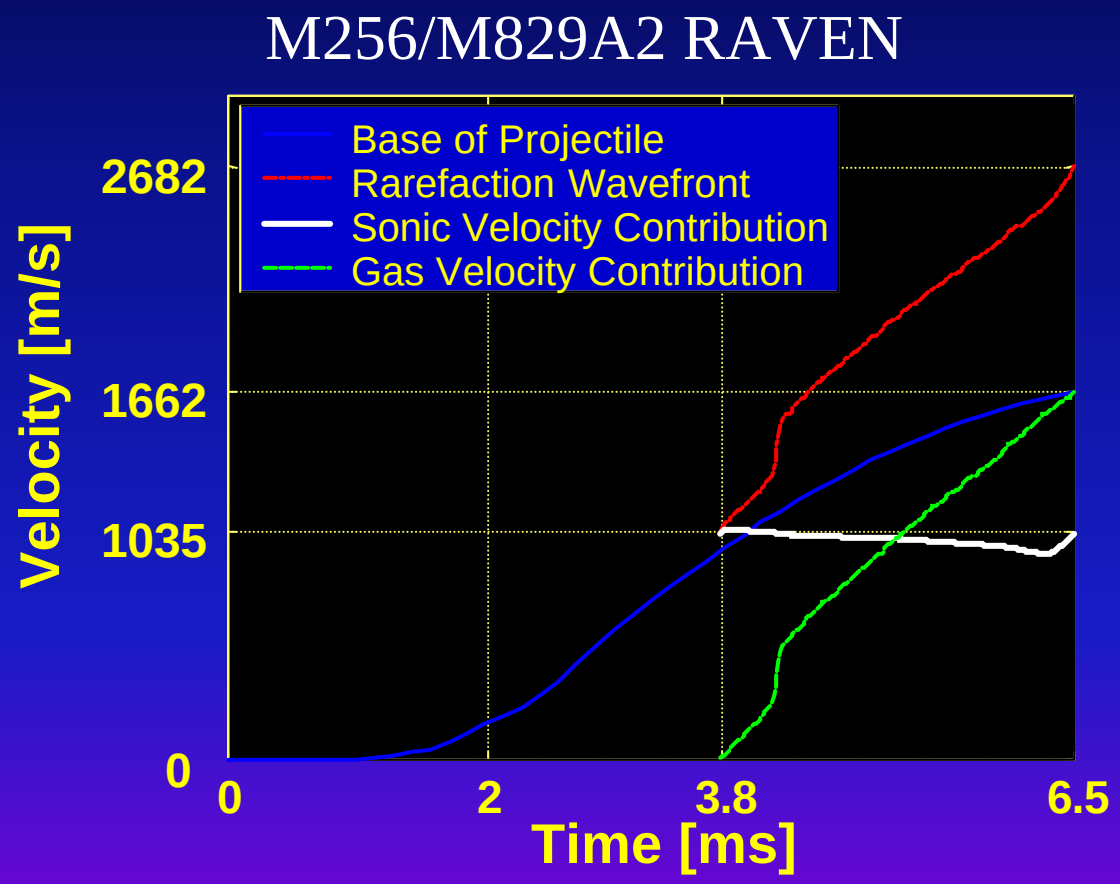
Computed using back-propagation of rarefaction wave front from the muzzle at shot exit

M256/M829A2 RAVEN



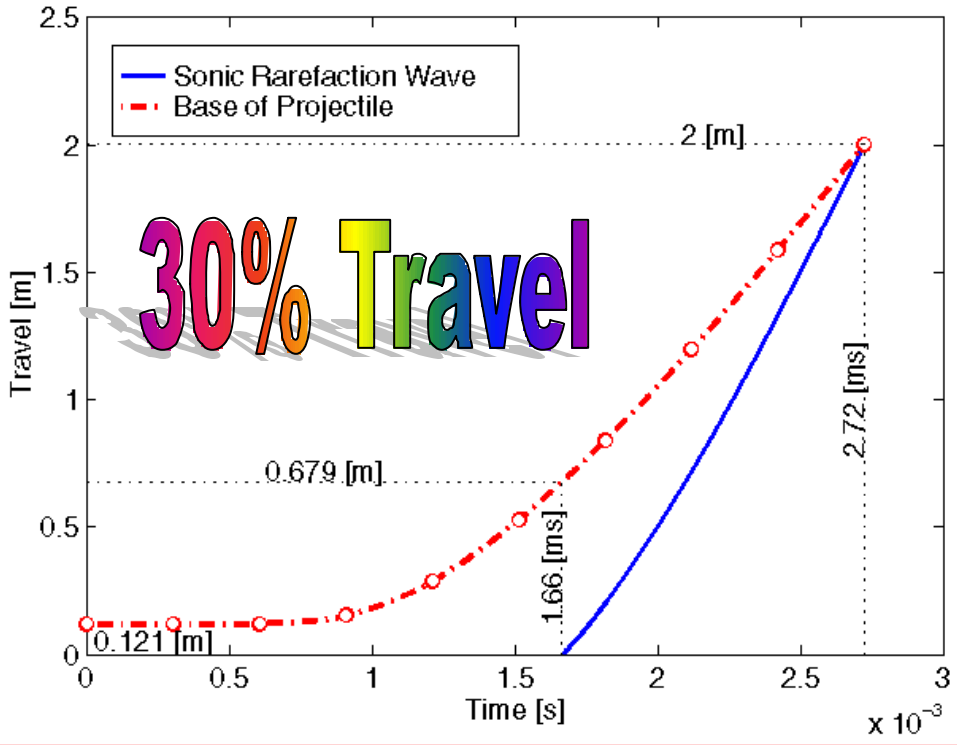
Rarefaction Wave Progression

- The speed of the rarefaction wave front includes gas velocity and sonic velocity contributions.

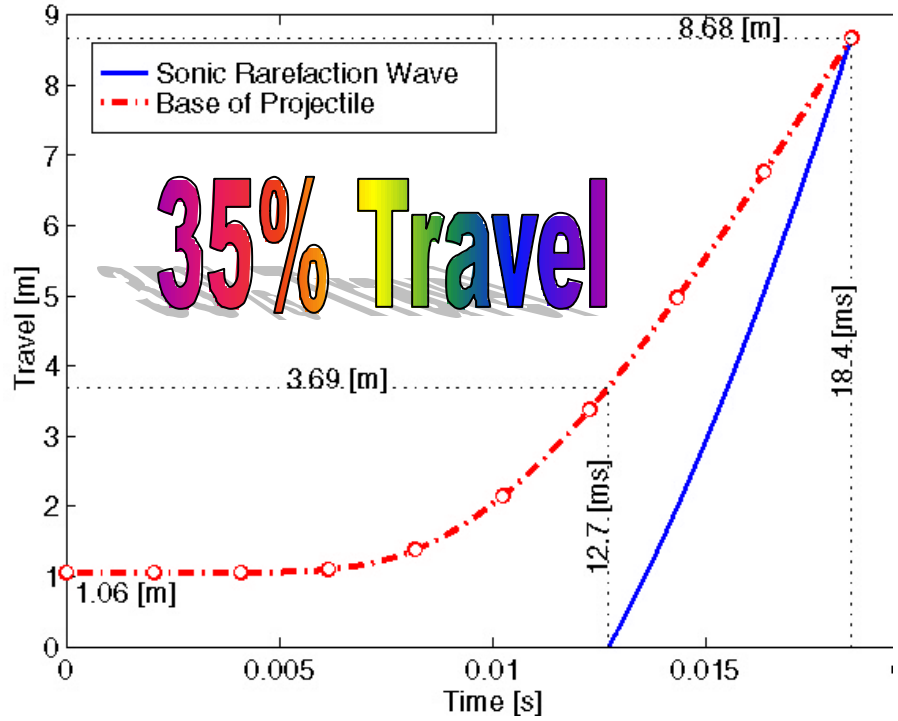


25mm & 155mm RAVEN's

M242/M919

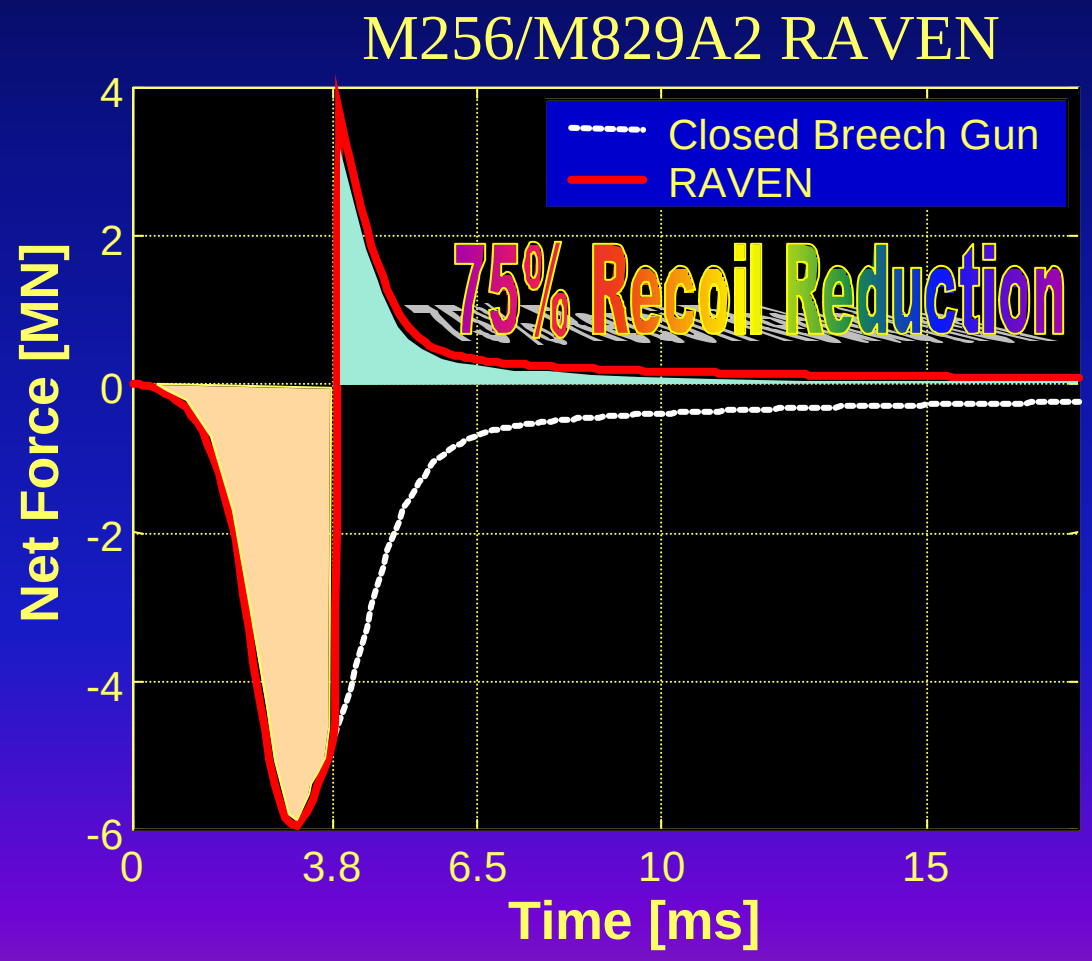


155mm Zone 6 XM297

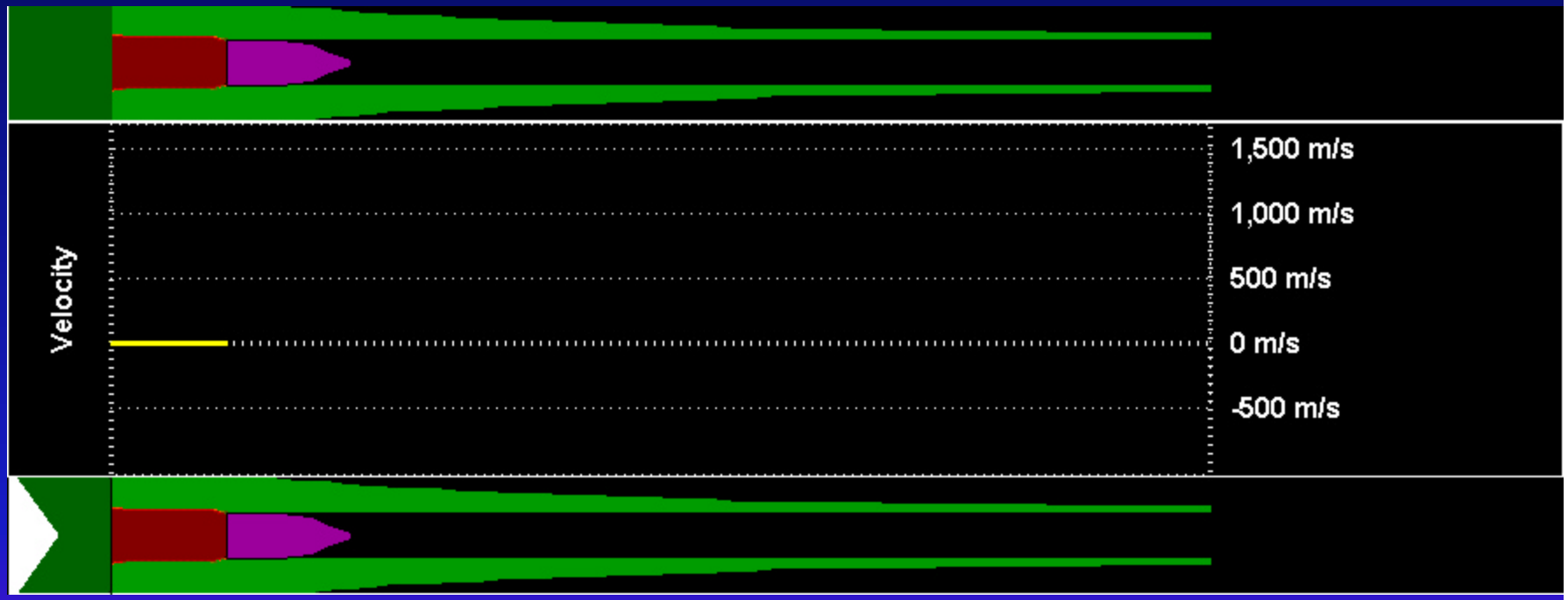


Recoil Reduction

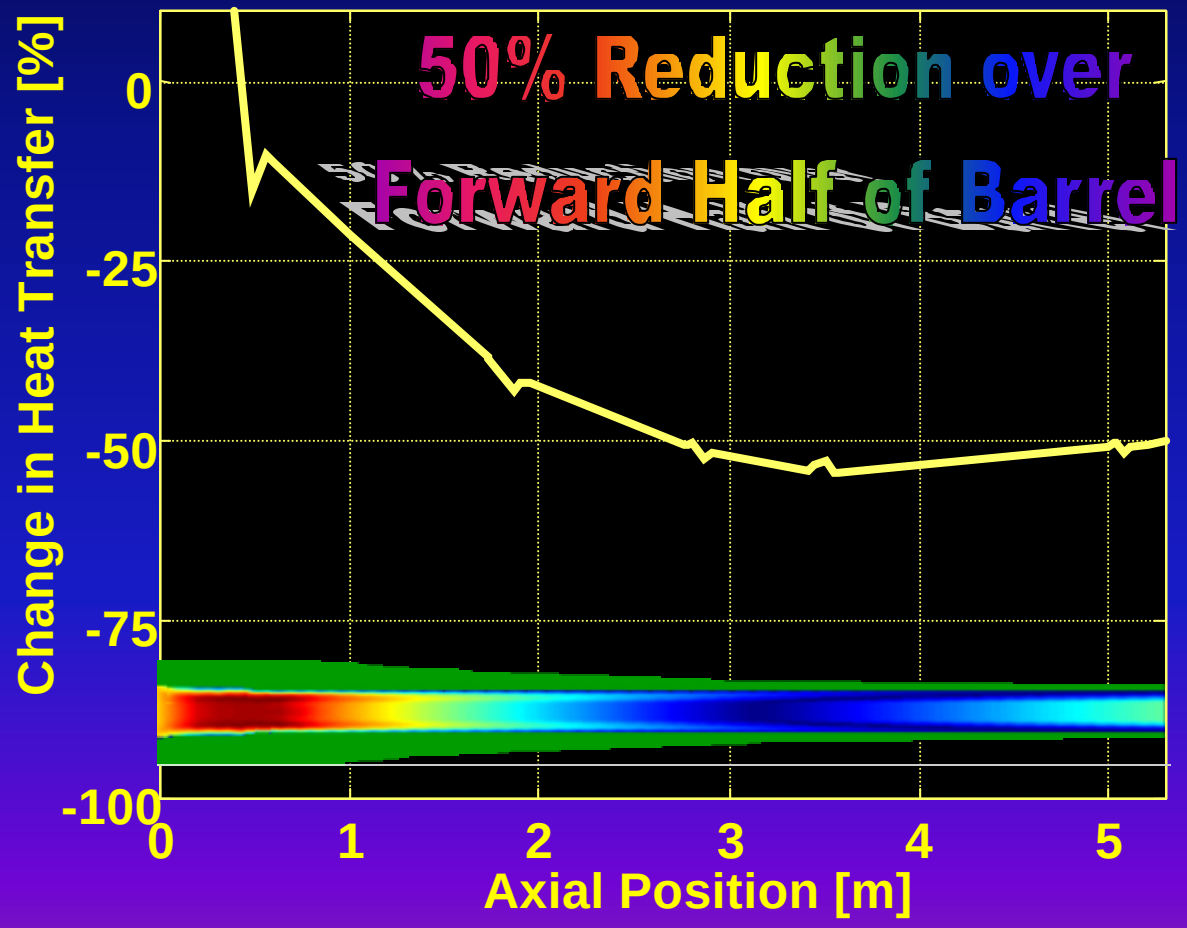
Simulation incorporating an expansion nozzle.



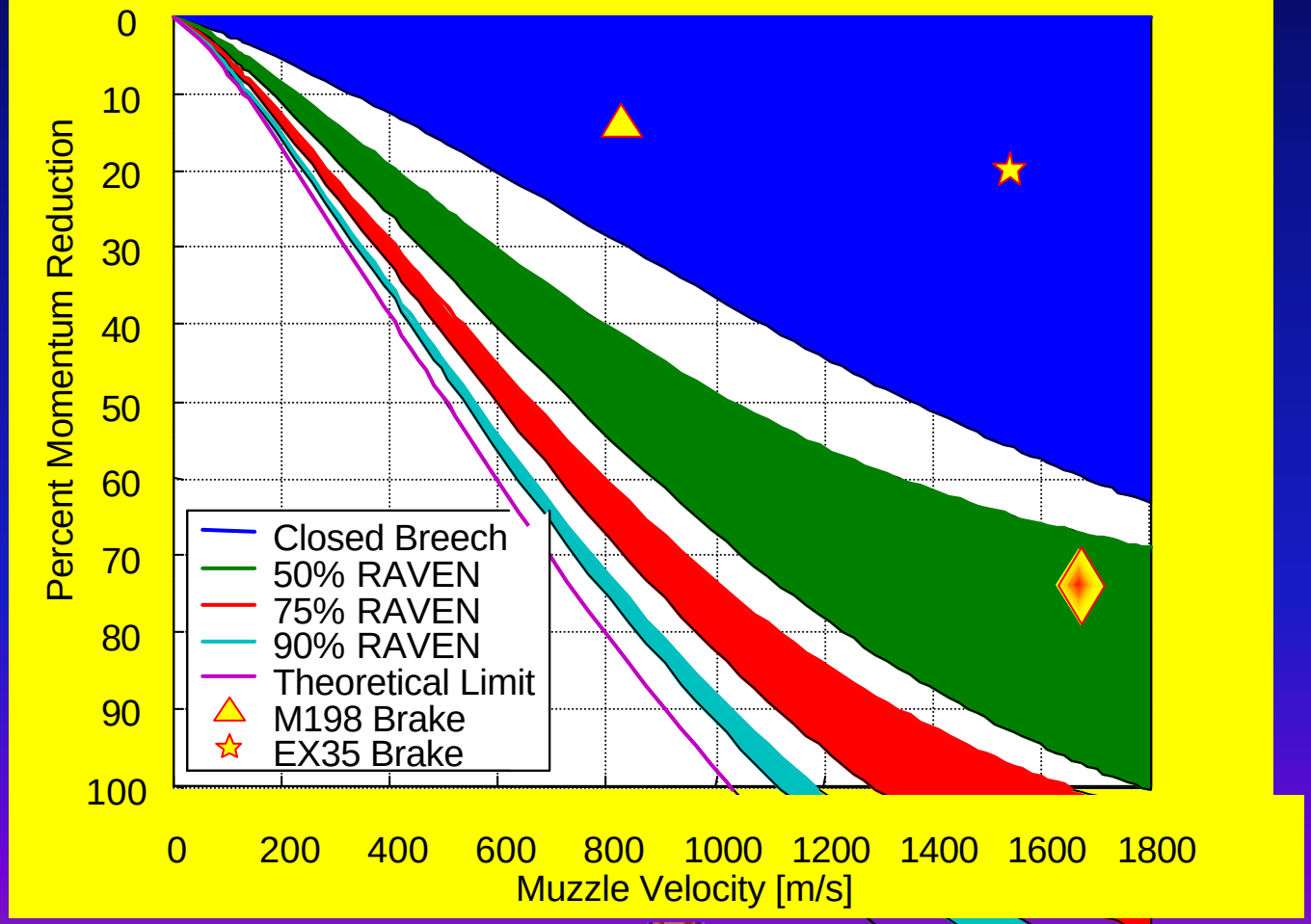
Gas Velocity Animation



RAVEN Bore Heat Reduction



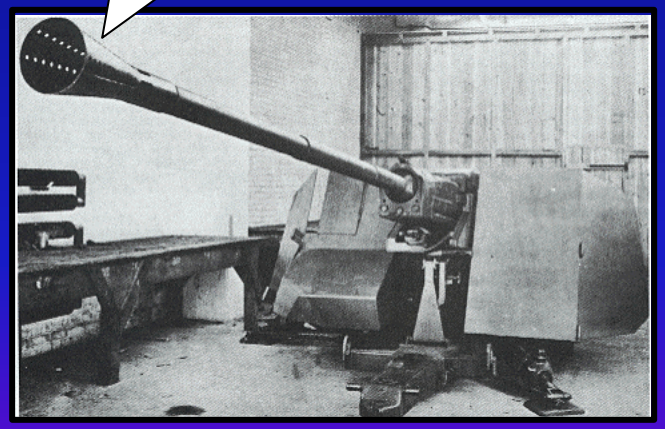
Momentum Reduction Potential



Comments on Back Blast

- Flash suppressors reduce signature by cooling escaping propellant gas using a nozzle.
- Gases Exiting the RAVEN Nozzle are directed away from the vehicle.

Cone flash suppressor for WWII AAA



Comments on Back Blast

- Danger zone extent behind prior large caliber recoilless is similar to current TOW missiles.

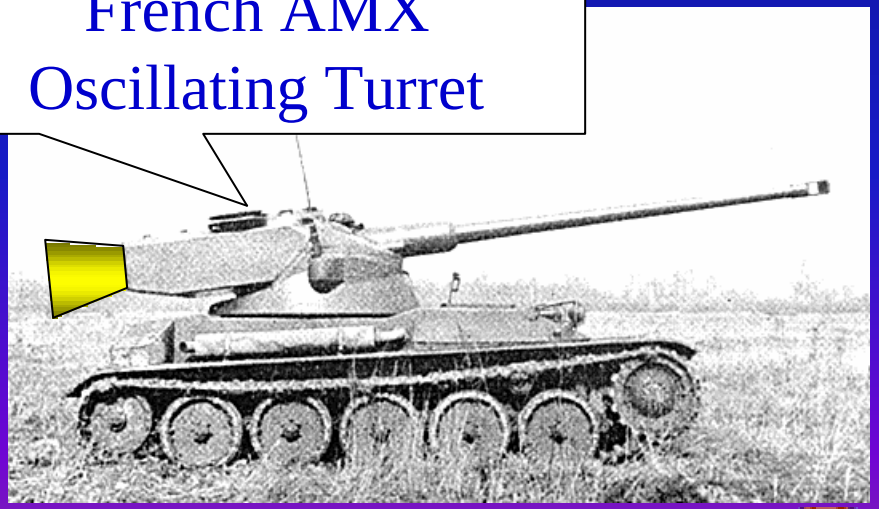
Source: AMCP 706-238 Recoilless Rifle Weapon systems on 105mm M27 (8 lb_m charge) & FM 23-34 TOW Weapon Systems.

Some External Guns

Russian SPH
Pedestal Mount

GDLS LPT LAV
Pedestal Mount

French AMX
Oscillating Turret



Inertial Breech Operated R105 RAVEN 105mm Swing Chamber FCS-MR Gun.

Mass Behind Trunnions Results in Improved Balance and Stabilization

Swing Chamber From Multi-Role Gun to Avoid Age Long Recoilless Rifle Loading Dilemma

Elevated RAVEN Gun Pod

ELEVATED TOW SYSTEM (ETS)

The mast mounted TOW system developed by Delco in conjunction with Falck-Schmidt of Denmark provides a unique battlefield capability. Chassis mounted, it is a highly mobile, armored TOW platform capable of reconnaissance and engagement from defilade.

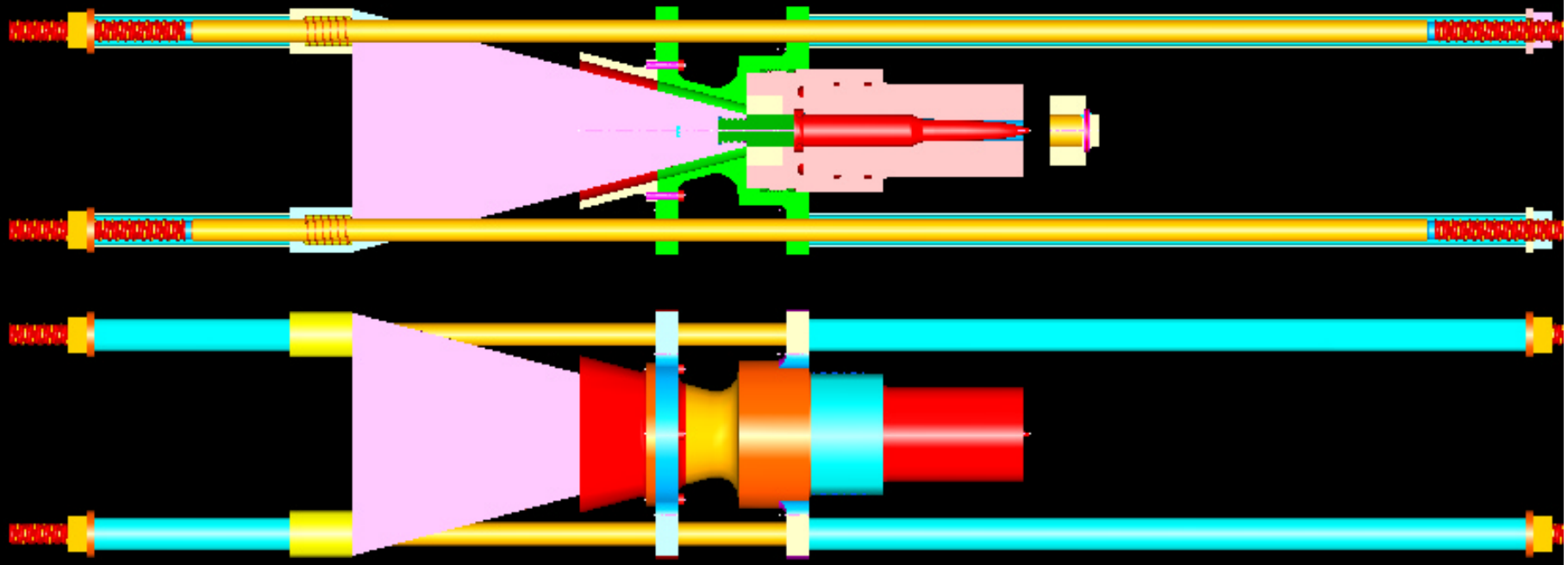
Applications

FCS

UAV, MAV, & UCAV

RAVEN 35MM Demonstrator

To Be Fired August 2001



In collaboration with ARES

Close Combat Armament Center

BENET LABS

Eric Kathe

Metrics†

Technology Readiness Level

- Currently: TRL 3
  - Analytical and experimental critical function and/or characteristic proof of concept.
- Soon to be: TRL 4
  - Firing single shot 30mm Gau-8 RAVEN will achieve: "Component and or breadboard validation in relevant environment."

Research & Development Degree of Difficulty (R&D^3)

- R&D^3 Level IV
  - Probability of Success in "Normal" R&D effort 50%.
  - Difficulty is anticipated...
  - Multiple technological approaches need to be pursued.

† Reference: John C. Mankins, Advanced Projects Office, "Technology Readiness Levels," April 6, 1995 & "Research & Development Degree of Difficulty", March 10, 1998, NASA

Summary

- RAVEN propulsion provides revolutionary performance in recoil mitigation.
- A new class of cannon may be on the horizon.